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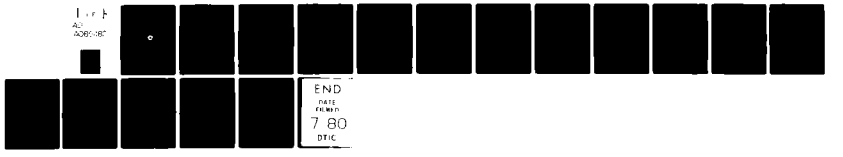

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DISCRETE ADDRESS BEACON SYSTEM FRONT END PROCESSOR/ EN ROUTE CENTRAL COMPUTER COMPLEX PROTOCOL

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April 1980

Final Report

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16. Abstract

The FAA has developed the Discrete Address Beacon System (DABS) as an evolutionary replacement for the current Air Traffic Control Radar Beacon System (ATCRBS). The DABS sensor, singly and in cooperation with other DABS sensors, will provide surveillance of, and two-way digital communications with aircraft equipped with DABS transponders, and provide surveillance of ATCRBS-equipped aircraft.

Surveillance data and data link services will be provided via suitable land lines to Air Traffic Control (ATC) facilities (terminal and en route). The DABS/ATC interface consists of two digital links to each facility: a two-way communications link and a one-way surveillance link from sensor to ATC. The Common ICAO Data Interchange Network (CIDIN) protocol is used on the two-way communications data link. When DABS is interfaced to an en route ATC facility, a special device, called the front end processor (FEP) is used to perform translation between the CIDIN protocol and the protocol used by the En Route Central Computer Complex (CCC). This document defines the protocol to be used between the FEP and the En Route CCC.

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METRIC CONVERSION FACTORS

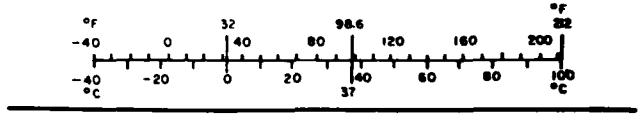
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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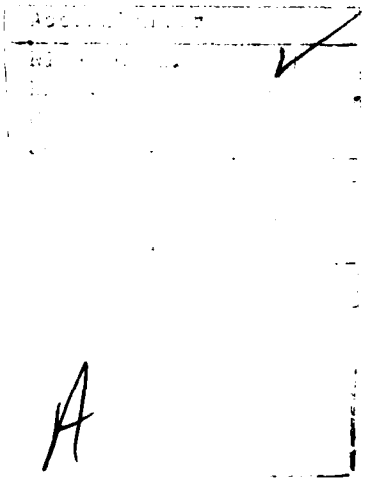

SECTION 1
INTRODUCTION

The Discrete Address Beacon System (DABS), when deployed within the National Airspace System (NAS), will provide surveillance of, and two-way digital communications with aircraft equipped with DABS transponders, and provide surveillance of ATCRBS-equipped aircraft.

Surveillance data and data link services will be provided to Air Traffic Control (ATC) facilities (terminal and en route). Each DABS sensor will have two digital links to each ATC facility: a two-way communications link and a one-way surveillance link from sensor to ATC. The surveillance link is not addressed in this document. Surveillance data formats and the ATC interface hardware required for receipt of these messages are described in References 1 and 2, respectively.

All communications messages transmitted and received by DABS are in accordance with the protocol and formats of the Common ICAO Data Interchange Network (CIDIN). When DABS is interfaced to the en route ATC system, all communications messages transmitted on the two-way link between each DABS sensor and the en route center will be processed by the Front End Processor (FEP) which will be located at the ATC facility. The FEP is a DABS communications processor which provides translation between the CIDIN protocol and formats and the protocol used by the En Route Central Computer Complex (CCC). The purpose of this document is to define the protocol and message formats used between the FEP and the En Route CCC. This protocol is sometimes referred to as the FEP/9020 protocol.

SECTION 2

FEP INTERFACES

2.1 DABS/FEP INTERFACE

Each DABS sensor interfaced to a particular en route ATC facility shall have it's two-way communications link interfaced to the FEP. Incoming DABS-to-ATC messages shall be tagged by the recipient interface with the identity of the sensor. The FEP shall direct ATC-to-DABS messages received from the En Route Central Computer Complex (CCC) to the desired sensor interface. Message exchanges between the DABS and FEP shall conform to the CIDIN protocol. DABS-to-ATC and ATC-to-DABS messages, as well as the CIDIN protocol to be used, are specified in Reference 1.

2.2 FEP/EN ROUTE CCC INTERFACE

The interface between the DABS Front End Processor (FEP) and the En Route CCC is specified in Reference 2.

SECTION 3

FEP/EN ROUTE CCC COMMUNICATIONS FORMATS

The following paragraphs describe the frame format which is used for all communications between the FEP and the En Route CCC (also called the 9020 CCC). Also defined in the following paragraphs are the FEP/9020 CCC protocol messages and formats. DABS-to-ATC messages received by the FEP from DABS are placed within the Data Block of the frame and transmitted to the 9020 CCC. ATC-to-DABS messages are also placed in the same format by the 9020 CCC. FEP/9020 CCC protocol messages (i.e., messages which originate or terminate in the FEP) are also placed into the Data Block of the frame by the FEP and the 9020 CCC.

3.1 FRAME FORMAT

All messages to be transferred between the FEP and the 9020 CCC shall consist of one Header field followed by one, variable length, Data Block as shown in Figure 3-1. The Header field is 24 bits in length and contains information about the Data Block. The Data Block is an integral number of bytes (byte = 8 bits) in length and contains the message type code and message contents being transferred between the 9020 CCC and the FEP. The minimum length of the Data Block is one byte and the maximum length is 250 bytes.

3.1.1 Header Field Content

Figure 3-2 shows the detailed content of the 24 bit Header field. The following paragraphs describe the Header field contents:

3.1.1.1 Label (bits 1 and 2)

Label is a 2-bit field which is always encoded as binary ones.

3.1.1.2 Retransmit (Rtx) (bit 3)

A binary zero setting of bit 3 indicates that the message number in bits 17-24 is a sequentially ordered number denoting that a new message follows in the Data Block. A binary one setting of bit 3 indicates that the message number in bits 17-24 is not sequentially ordered and is the original message number of a message being retransmitted in the Data Block.

Messages shall be retransmitted upon request or whenever a message requiring an Accept is not accepted, rejected, or requested for retransmission within the DABS Retransmission Time

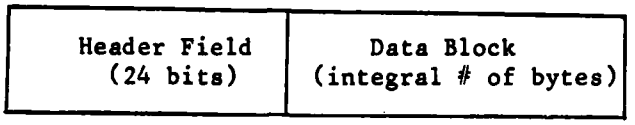

Figure 3-1. Frame Format

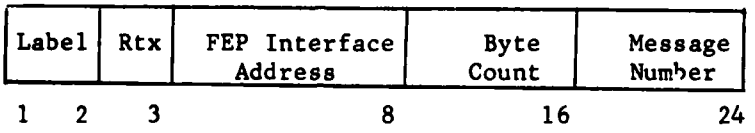

Figure 3-2. Header Field Content

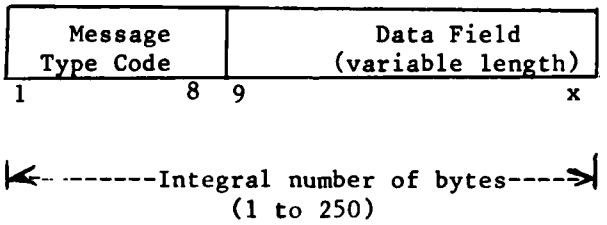

Figure 3-3. Data Block Content

Parameter (DRTP). DRTP is defined as 3(0.5-5.0, .5)* seconds. The sending processor will continue to attempt retransmission every DRTP seconds for the DABS Transmission Retry Times (DTRT) parameter. DTRT is defined as 1(0-10, 1) times. Failure to deliver after DTRT times shall be logged and the subject message discarded.

3.1.1.3 FEP Interface Address (bits 4-8)

Bits 4 through 8 contain the 5-bit address of the interface from which, or to which, the message is being sent. In the case of ATC-to-DABS messages, it is the address of the DABS site to which the message is to be sent. In the case of DABS-to-ATC messages, it is the address of the DABS site which transmitted the message. In the case of FEP/9020 CCC protocol messages it is the address of the FEP. The FEP address is 00000.

3.1.1.4 Byte Count (bits 9-16)

Bits 9 through 16 contain the number of bytes contained in the Data Block. These bits represent a number from 1 to 250 bytes. Bit 9 is the most significant bit and bit 16 is the least significant bit. This byte count does not include the three bytes of the Header field.

3.1.1.5 Message Number (bits 17-24)

Bits 17 through 24 contain the message number for this message. These bits represent a number from 1 to 255. Messages sent across the FEP/9020 CCC interface are numbered to maintain interface integrity and to provide a reference to messages previously sent. FEP originated messages will be numbered by the FEP and 9020 CCC originated messages will be numbered by the 9020 CCC.

Messages in either direction shall be sequentially numbered in the order sent unless the retransmit bit is set in the Header field. When the retransmit bit is set the message number shall be the same as that previously used for the same message.

Messages are sequentially numbered from 1 to 255. When a message numbered 255 is sent, the next message will normally be numbered 1. If either side of the interface receives a Reset

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* NOTE: parameters specified herein utilize the following notation:

$$p = w(x\text{-}y, z)$$

Meaning: The parameter p shall be included in the program and given the nominal value w. All programs using that parameter shall accept a range of parameter values from x to y in steps of z.

Message it should expect the next message to have a message number of 1. The Reset Message will always have a message number of zero in its Header field. The message transmitted following a Reset Message will have a message number of one.

3.1.2 Data Block Content

The format of the Data Block is shown in Figure 3-3. It has a variable length, with a minimum length of one byte and a maximum length of 250 bytes.

The Data Block consists of a one-byte message type code and a 0-249 byte data field. For DABS-to-ATC messages, this content (type code and data field) is the content of the Link Data Field (see Reference 1) which the FEP places into the Data Block unaltered. Conversely, the contents of the, unaltered, Data Block of ATC-to-DABS messages received from the 9020 CCC will be the Link Data Field of the CIDIN protocol format for transmission to the DABS site.

The Data Blocks for the FEP/9020 CCC protocol messages are similar to those discussed above. However, the message type codes and Data Field contents are unique to this interface. They are discussed in detail in Section 3.2.

3.2 FEP/9020 CCC PROTOCOL MESSAGES

Messages which originate or terminate in the FEP are called FEP/9020 CCC protocol messages (or En Route CCC protocol messages). The following paragraphs define the FEP/9020 CCC protocol messages (message type and data field) and describe the conditions under which each message is used to effect the "protocol" between the FEP and the 9020 CCC.

3.2.1 FEP/9020 CCC Protocol Message Formats

Table 3-1 lists the Data Block formats (message type code plus data field) of the FEP/9020 CCC protocol messages. Note that some of the messages do not contain a data field.

3.2.2 FEP/9020 CCC Protocol Messages-Data Field Content Definitions

The following paragraphs define the contents of the FEP/9020 CCC protocol message data fields.

3.2.2.1 FEP Status

The FEP status field shall contain information relative to the status of the FEP. Bits 9-12 are coded in hexadecimal as follows:

0 - no error
1 - voting error
2 - uncorrectable memory error
3 - unable to receive from 9020 CCC

Initialization

0 0 0 1 0 0 0 0
1 8

Interface Initialization

0 0 0 1 0 0 0 1
1 8

Initialization Response

0 0 0 1 0 0 1 0	FEP Status	Sensor Interface Status
1 8	9 16	17 32

FEP Status

0 0 0 1 0 0 1 1	FEP Status	Sensor Interface Status
1 8	9 16	17 32

Accept

0 0 0 1 0 1 0 0	Ref. Message No.
1 8	9 16

Reject

0 0 0 1 0 1 0 1	Error Code	Ref. Message No.
1 8	9 16	17 24

Retransmit

0 0 0 1 0 1 1 0	Ref. Message No.
1 8	9 16

Reset

0 0 0 1 0 1 1 1
1 8

FEP Test

0 0 0 1 1 0 0 0	Test Data
1 8	9 40

FEP Test Response

0 0 0 1 1 0 0 1	Test Data	Ref. Message No.
1 8	9 40	41 48

Table 3-1. FEP/9020 Protocol Messages

4 - FEP overload
5 - FEP startover
6 - bad 9020 CCC test response
7 - message number received greater than DWMP from last message

Other codes are not used.

3.2.2.2 Referent Message Number

The Referent Message Number contained in the Reject, Accept, Retransmit and FEP Test Response messages is a copy of the message number from the header field of the message for which the response message is being generated. If a Reject, Accept, Retransmit or FEP Test Response message is received with a Referent Message Number for a message not in storage, it shall be ignored.

3.2.2.3 Sensor Interface Status

The Sensor Interface Status field shall contain information relative to the status of the interfaces between the FEP and attached DABS sensors. Each bit of this field shall indicate the status of the interface to one of the attached sensors. The first bit of the Sensor Interface Status field (bit 17 of the protocol message) corresponds to FEP interface address 00001; the second bit corresponds to FEP interface address 00010, etc. The bits are defined as follows:

0 - CIDIN communications available (or no sensor interface)
1 - CIDIN communications not available

3.2.2.4 Error Code

Bits 9 through 16 of the Reject message indicate the reason for rejection of a particular message. It is encoded in hexadecimal as follows:

01 = incorrect address in the Header field
02 = message rejected by addressed sensor
03 = communications outage with addressed sensor

3.2.2.5 Test Data

Test Data is a 32-bit field. Contents may be defined by the originator. Each message may be different. The test data field received in a Test message shall be duplicated in the associated Test Response message.

3.3 FEP/9020 CCC PROTOCOL

The following paragraphs define the use of the FEP/9020 CCC protocol messages.

3.3.1 Initialization Message (Type Code 0001 0000)

The Initialization message shall be sent by the 9020 CCC whenever the 9020 CCC is initialized. When the FEP receives this message it shall initiate a startover, i.e., clear all pending message files, initialize all hardware and software, and determine the status of all sensor interfaces. Following a successful startover, the FEP shall respond with an Initialization Response message with the FEP Status field set to code 5. If the startover is unsuccessful, the FEP shall respond with an Initialization Response message with the error detected code in the FEP Status field. The 9020 CCC shall repeat the Initialization message every 5 seconds until an Initialization Response message is received with no indicated errors. The Header field of the Initialization message shall contain a message number of zero.

3.3.2 Interface Initialization Message (Type Code 0001 0001)

The Interface Initialization message shall be sent by the 9020 CCC whenever the 9020 CCC has completed a startover. In addition, the 9020 CCC (in order to re-establish communications in case of a FEP startover) shall send the Interface Initialization message whenever it detects a loss of communications with the FEP. When the FEP receives this Interface Initialization message, it shall immediately respond with an Initialization Response message followed by transmission of any pending messages for the 9020 CCC. The Interface Initialization message shall be repeated every 5 seconds until the 9020 CCC receives an Initialization Response message with no indicated errors. The Header field of the Interface Initialization message shall contain a message number of zero.

3.3.3 Initialization Response Message (Type Code 0001 0010)

The FEP shall send the Initialization Response message upon receipt of either an Initialization or Interface Initialization message from the 9020 CCC. The message number in the Header field shall be set equal to one. No other message transactions shall occur until a successful initialization has been completed. Receipt of any other message types shall be ignored.

3.3.4 FEP Status Message (Type Code 0001 0011)

The FEP Status message shall be sent to the 9020 CCC to indicate error conditions which have occurred in the FEP or changes in the status of the FFP/sensor interfaces.

3.3.5 Accept Message (Type Code 0001 0100)

The Accept message is returned to the FEP by the 9020 CCC to indicate receipt of valid DABS-to-ATC messages and the FEP Status or Reset messages.

The Accept message is returned to the 9020 CCC by the FEP to indicate successful delivery of a ATC-to-DABS message to the addressed DABS sensor or the receipt of a Reset message.

3.3.6 Reject Message (Type Code 0001 0101)

The Reject message shall be returned whenever either the 9020 CCC or the FEP receives a message with an illegal FEP Interface Address in the Header field, or whenever the FEP is unable to forward a message received from the 9020 CCC to the addressed DABS sensor.

3.3.7 Retransmit Message (Type Code 0001 0110)

The Retransmit message shall be used by either the 9020 CCC or the FEP to request that a bad message or a missing message be transmitted again.

The Retransmit message will occur as the result of parity errors, improper message length, and unrecognizable messages. In addition, this message is used to request missing messages. This can occur when a message is received with a message number other than the expected message number. If the received message number (for messages other than Reset, Initialization or Interface Initialization) is less than DWMP (DABS Wrong Message Parameter) greater than the message number expected, the recipient shall request retransmission of messages with the intervening message numbers. DWMP is defined as 4(1-10, 1).

Receipt of a Retransmit message requesting a message not in storage (e.g., response messages) shall be ignored. There is no requirement to store a retransmit message for possible retransmission.

3.3.8 Reset Message (Type Code 0001 0111)

The Reset message will cause the message numbering to be reset so that the next message transmitted from both the FEP and the 9020 CCC will have a message number equal to one. The message number contained in the Header field of the Reset message shall always be equal to zero. A Reset message shall be transmitted when a received message number differs from the expected message number by a number equal to or greater than DWMP. New messages can be transmitted following receipt of an Accept for the Reset message or the generation of the Accept to a received Reset message. Once a Reset message is transmitted, all messages

except for the Accept of the Reset or another Reset shall be ignored.

Note: Messages received with wrong message numbers within DWMP which are, in all other respects, correct shall be considered acceptable.

3.3.9 FEP Test Message (Type Code 0001 1000)

The FEP Test message is used to determine the status of the interface between the FEP and the 9020 CCC. The FEP Test message can be forwarded as the result of an operator input to the FEP or to the 9020 CCC. In addition, the 9020 CCC shall automatically send a Test message every TMTP seconds when no other transactions have taken place on the FEP/9020 interface. The Test Message Time Parameter (TMTP) is defined as 10(5-60, 5) seconds. The 9020 CCC shall determine FEP failures and output such status information to maintenance personnel.

3.3.10 FEP Test Response Message (Type Code 0001 1001)

The FEP Test Response message is transmitted whenever the FEP or the 9020 CCC receives a FEP Test message.

REFERENCES:

1. Report No. FAA-RD-80-14, DABS/ATC Facility Surveillance and Communications Message Formats, April 1980

2. Report No. FAA-RD-80-38, ATC Facility Hardware Interfaces for DABS, April 1980